

SSI Data Preparation

Sequential Proving of Track Circuits

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Table of Contents

Description	Page
1. INTRODUCTION.....	2
2. PRINCIPLES OF OPERATION AND APPLICATION	2
3. DATA	6
3.1 Identities.....	6
3.2 General	6
3.3 Uni-directional lines	7
3.3.1 General.....	7
3.3.2 Facing Points in Track Circuit.....	8
3.3.3 Trailing Point or Diamond Crossing in Forward Track Circuit.....	8
3.3.4 Set Back Moves.....	9
3.3.5 No Forward Track Circuit	9
3.4 Bi-directional lines.....	9
3.4.1 General.....	9
3.4.2 Facing Points in Track Circuit.....	10
3.4.3 Trailing Point or Diamond Crossing in Forward Track Circuit.....	11
3.4.4 Train Reversal - First Track Circuit in Route.....	11
3.4.5 No Forward Track Circuit in One Direction	13
3.5 Cut-section track circuits	13
3.6 No clear track circuit between successive trains.....	15
3.7 Cross-boundary.....	16
3.8 Track Circuit Type Requiring Extra Delay	17
3.9 Effect on Sub-route Locking	17
3.10 Optional De-activating Facility.....	18
4. ADVICE TO STAFF	20

SSI Data Preparation

Sequential Proving of Track Circuits

I. Introduction

Additional safeguards against irregular operation of track circuits may be required in areas where track circuit operation cannot be relied upon, e.g. areas prone to leaf-fall contamination. Failure of a track circuit to detect a train can lead both to false aspect clearance, and to improper operation of comprehensive approach locking or TORR look-backs. (Wrongful release of route locking ahead of a train is already protected against - see SSI8003-10F.)

This document provides a data method for dealing with such areas of poor track circuit operation, and builds on that already employed in the Woking control area where sequential proving of track circuits was specifically introduced to address the problem of false aspect clearance in areas prone to leaf-fall contamination.

Scheme specifiers please note - this method of sequential proving of track circuits is to be applied sparingly to signalling schemes, i.e. only where justified by the level of assessed risk, due to the constraints on data volume and Interlocking timings.

The areas where sequential proving of track circuits are required are expected to be identified on the signalling scheme plans. It is also expected that additional control tables will be prepared to specifically define the sequential proving controls required.

2. Principles of Operation and Application

Irregular operation of track circuits may result in a train not being registered on entering a track circuit or, the occupation having been registered, in the wrongful clearing of a track circuit under a train. The method chosen for safeguarding against this irregular operation is to prove the sequential operation of the track circuits.

A sequential proving control is applied at track circuit input level within the CI which prevents an occupied track circuit from being considered clear again by the Interlocking unless the train is proved as occupying the next track circuit in sequence (the forward track circuit). Alternatively this sequential proving control will time out after the track circuit, as input into the Interlocking, has been continuously clear for 15 seconds. This will allow automatic system recovery after irregular operation, such as a track circuit or power supply failure.

The objective of this sequential proving control is to ensure that the train is protected by at least one track circuit, either under or in rear of the train, remaining in an occupied state. It must be recognised that this sequential proving control is not a 100% safeguard against track circuits clearing too soon, for example it will not prevent the rear track circuit under a train from clearing early as a train passes over a track circuit joint, nor will it necessarily protect the train when the forward track circuit is occupied by another train.

The limited effectiveness of this control should be clearly recognised by all parties involved in the data preparation, checking and testing process. It is

SSI Data Preparation

Sequential Proving of Track Circuits

considered that a realistic level of effectiveness has been achieved by this document, and that any further attempts to increase effectiveness are likely to introduce an unnecessary level of complication which will be counter productive, introduce unacceptable risk and open an even bigger can of worms!

In the absence of any generic principles or standards defining sequential proving control, the principles deduced by the SSI Signalling Principles Group, both for its operation and application, now follow. It has been assumed that the sequential proving control will only be applied in those areas where it is justified, i.e. it will not be applied indiscriminately.

1. When an occupied track circuit is reported to the Interlocking as becoming clear, it shall continue to be considered as occupied for any Interlocking purpose until the train is occupying the forward track circuit.
2. Where there is a choice of forward track circuit on bi-directional lines or at diamond crossings, then the selection of forward track circuit shall be based on the route set (application of this principle means that track circuit re-clearing will be delayed after hand-signalled moves).

Precautions shall be taken against a track circuit being wrongly cleared after a reverse signalled move. Where there is a choice of forward track circuit at facing points, then the selection of forward track circuit shall be based on the controlled position of the points.

3. Where the forward track circuit is in a separate signal section and may legitimately be occupied by another train, then the track circuit shall not be allowed to re-clear until the train has been signalled into and is occupying the forward track circuit. This is only effective if the signal proves the forward track circuit is clear. This will avoid, as far as possible, the sequential proving being falsely operated by a forward train.
4. Where the forward track circuit may be occupied by another train in the same signal section (i.e. permissive working), then no additional controls on the track circuit sequencing are required. The standard sequential proving control will prevent the forward track circuit from re-clearing and so protect the two trains from other moves entering the section.
5. The sequential proving control should be self-resetting after a time in order to allow a track circuit to clear after:
 - intermittent track circuit failures,
 - power failures,
 - track circuit testing or
 - adjacent short track circuits clearing in the wrong order.

SSI Data Preparation

Sequential Proving of Track Circuits

The time used should be greater than the longest likely track circuit irregular operation. Generally 15 seconds has been used as per sub-route freeing, but this may be increased if found necessary. It is accepted as a limitation of this sequential proving control that a track circuit will be reset to the clear state under a train if a train fails for a continuous period of 15 seconds to have its presence registered by this track circuit.

6. Where there is no forward track circuit in the direction of travel (e.g. leading into sidings), then the final track circuit shall not be considered as clear until the sequential proving control has self-reset after time.
7. The sequential proving control shall both allow the correct satisfying, and avoid unnecessary failures, of interlocking functions that either prove a sequence of track circuit operations or prove track circuit occupation.

This is achieved by maintaining as occupied a track circuit already registered by the Interlocking as occupied, if the track circuit clears before the forward track circuit is occupied. In addition, the track circuit shall be delayed in clearing such that any Interlocking function requiring this and the forward track circuit occupied together can be satisfied. (This has been done by requiring the forward track circuit occupied for two seconds thus ensuring both track circuits are occupied together for at least one major cycle of the Interlocking.)

A successful track circuit occupation test will thus prove (track circuit failures apart) that a track circuit has been registered as occupied either on entry of the track circuit or later as a train proceeds through the track circuit. The following Interlocking functions using track circuit occupation tests will thus be both correctly satisfied and avoid unnecessary failure.

- functions dependant on track circuit sequences, such as train-in-section proving for approach locking release and TORR (each track circuit has been actually occupied and cleared in the correct sequence)
- approach control by track circuit occupied dead (a train has actually reached a given point)
- approach control by track circuit occupied for time (a train has actually reached a given point at least the requisite time ago)
- freeing of opposing locking by track circuit occupied for time (a train has actually reached a given point at least the requisite time ago)

Any other Interlocking functions present that use track circuit occupation tests must be checked to ensure that the sequential proving control does not introduce an unsafe condition.

SSI Data Preparation

Sequential Proving of Track Circuits

8. The sequential proving control may also need to be applied to the track circuit on the immediate approach to the affected area, in order to guard against non-operation of the first track circuit within the affected area. Thus if there is a risk that irregular operation may cause the latter track circuit not to detect a train on initial entry, then the sequential proving control shall additionally be applied to the track circuit on the immediate approach to the affected track circuit.
9. The sequential proving control is not applied to HVI track circuits, except where they lead up to affected track circuits (as in Principle 8), as their inherent operating characteristics already give adequate safeguard against leaf-fall problems.
10. Track circuits may be combined before track circuit sequencing is applied, but track circuit sequencing must be applied before a track circuit is used in an Interlocking function and it must only be applied once to each track circuit whether singly or grouped.
11. As required by Signalling Principles Standard GK/RT0041, the track circuit indications given to the Signaller shall match the actual controls applied to signals, thus these indications shall be controlled by the state of track circuits after any sequential proving controls have been applied.
12. It has to be recognised that track circuit sequencing cannot be relied upon for enforcing accurate determination of train position, e.g. for clearance at points and diamond crossings or for initiation or releasing of level crossings. (If track circuits cannot be relied upon, then other means of train detection may be necessary in such situations.)
13. Each track circuit to which sequential proving control is applied will typically incur an extra nine data processing points (twelve if bi-directional). Thus the effect of this has to be considered when deciding Interlocking boundaries - simple blanket application to all track circuits in an Interlocking without considering need is not intended.
14. Where sequential proving control has been applied to a track circuit, the enhanced track circuit bobbing protection normally applied to the freeing of the sub-routes associated with that track circuit may be dispensed with. If such protection is retained, say for consistency, then measures have to be taken to ensure that the combination of this protection and the sequential proving control do not result in extended freeing times. Thus the test for own-track-circuit-clear-for-15-seconds used in sub-route freeing is always applied to the track circuit as input into the Interlocking.
15. An optional feature, provided if the Infrastructure Controller requires it, is the ability to de-activate and activate, i.e. switch off